

REMARKS / ARGUMENTS

In complete response to the Office Action dated September 28, 2010, on the above identified application, reconsideration is respectfully requested. Claims 36-39 are pending in this application.

With this amendment, claims 18, 20, 24-27, 29, and 32-35 are canceled and new claims 36-49 are added.

First Claim Rejection under 35 U.S.C. § 103:

Claims 18, 24-27, and 32-34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sato et al. (US 2001/0048973) in view of Mitzel (*Simple Silylhydrazines as Models for Si-N B-Donor Interactions in SiNN Units*).

These rejections are moot in view of the cancelation of the claims.

Second Claim Rejection under 35 U.S.C. § 103:

Claims 20 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sato et al. (US 2001/0048973) in view of Mitzel (*Simple silylhydrazines as models for Si-N B-donor interactions in SiNN units*) as applied above and further in view of Fessenden et al. (*An extension of and the reversibility of the silylamine-amine exchange reaction*).

These rejections are moot in view of the cancelation of the claims.

Third Claim Rejection under 35 U.S.C. § 103:

Claims 18 and 24-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sato et al. (US 2001/0048973) as applied above in view of Ishikawa (JP 06338497).

These rejections are moot in view of the cancelation of the claims.

Comparison of the Cited Art and the New Claims

New independent claims 36, 43, 44 and 49 are specific to trisilylamine as a silicon precursor. Claims 36 and 43 require a first synthesis reaction, the product of which is then used in a deposition. Claims 44 and 49 require that the deposition be by a Low Pressure Chemical Vapor Deposition (LPCVD). Each of these distinctions renders the instant claims patentable over the cited art for the following reasons.

Separate Synthesis Reaction for Trisilylamine + Hydrazines

Claims 36 and 43 require a separate synthesis reaction of trisilylamine and a hydrazine. The Examiner cites Sato et al (US 2001/0048973) as expressly suggesting a preliminary synthesis reaction as claimed:

Sato discloses ... that silylhydrazines may be formed in a preliminary reaction chamber and then fed to the reaction chamber [0062]. ... Regarding Claim 27, Sato discloses that ... silylhydrazine may be formed in a preliminary chamber and then fed to the reaction chamber [0068].

The Examiner is correct to a degree. Sato does disclose a pre-reaction but only for a specific circumstance:

Second Chemical Vapor Deposition Process

[0045] The second chemical vapor deposition process of the present invention is to form a silicon nitride film on a substrate by carrying out a preliminary reaction between the above feed gases, and feeding the resulting reaction gas mixture from which the solid compounds such as ammonium halide produced by the preliminary reaction has been eliminated.

[0049] In the second chemical vapor deposition process of the present invention, the solid compounds such as ammonium halide is intentionally allowed to separate out during this preliminary reaction, and the resulting reaction gas mixture from which the solid compound such as ammonium halide has been eliminated is fed to the chemical vapor deposition growth reaction. Any means can be employed in order to eliminate the ammonium halide precipitated. For

Thus, as is clear in context, Sato expressly suggests using a preliminary reaction chamber in cases where a solid will form as an undesirable reaction product. The issue with such reaction products is clogging of the pipes and valves of the film deposition system. Sato [0005]-[0008]. As is made clear in the instant application, precipitating reaction products are not generated by trisilylamine reactions with hydrazines. Page 5, lines 6-11. Consequently, the Examiner's *prima facie* case of obviousness would be logically flawed if applied to the new claims in that the express suggestion relied upon is not directed to the currently claimed subject matter. Applicant can see no other rationale or motivation based on the cited art that would lead one of ordinary skill in the art to insert a preliminary reaction step into a process using trisilylamine and a hydrazine.

Because claims 37-42 depend from claim 36, they are patentable over the art for at least the foregoing reasons.

LPCVD + Trisilylamine + Hydrazines

The use of trisilylamine with hydrazines for LPCVD depositions of SiN films is novel and not expressly suggested by the cited art. Applicant submits the combination is not obvious by any means permitted under KSR.

The Examiner has combined references in relation to the prior less focused claims to make An argument of *prima facie* obviousness. However the prior claims were not specific for LPCVD of TSA/hydrazines to make a SiN film. The two pertinent references are Sato et al (US 2001/0048973) and Ishikawa (JP 06338497).

- Scope and Content

Sato et al (US 2001/0048973) discloses a general direction to use hydrazines as a co-reactant with Silicon donating molecules [0031] to form SiN films under a general definition of CVD such as 0.1-760 Torr. [0036] Sato discloses a variety of Silicon donor species none of which are close to trisilylamine. [0031]; [0063]; [0065]; [0068]; [0069]; [0073].

Ishikawa (JP 06338497) discloses use of trisilylamine to form SiN films by reaction with ammonia under plasma enhanced CVD conditions.

- Differences between the Art and the Claims

While Sato describes pressure ranges that encompass LPCVD, the examples given are well above the 10 Torr limit now claimed and the Silicon donors used are unrelated to trisilylamine.

Ishikawa discloses a PECVD process using trisilylamine and ammonia.

Arriving at LPCVD of trisilylamine with a hydrazine requires extracting trisilylamine from the PECVD/ammonia system of Ishikawa and plugging it into a very narrow subset of the generic CVD conditions described in Sato.

- Reasons Against a Conclusions of Obviousness

Applicant notes that an express suggestion or overt motivation to arrive at the claimed subject matter is not present in the art. Applicant further submits that use of trisilylamine with ammonia under PECVD conditions does not form a basis to implicitly suggest the use trisilylamine with hydrazines under LPCVD conditions. This is particularly true given the significant differences between PECVD and LPCVD. See Application background at Page 1, lines 10-30. The very generic "any

silicon compound" direction of Sato is only reasonable in view of the fact that Sato means any and all forms of CVD including PECVD and LPCVD. [0036]. One of skill in the art would not read Sato as meaning, and would know that, silicon compounds that work for PECVD may or may not be effective under LPCVD conditions and vice versa. In technical terms, trisilylamine cannot be deemed an art recognized equivalent for the *same* purpose. MPEP 2144.06; MPEP 2143(B).

As is apparent from Sato, trisilylamine cannot be deemed "obvious to try" as one of "a finite number of identified, predictable solutions." MPEP 2143 (E). Sato forecloses any argument of selection from "a finite number" of silicon donors being at issue. [0031]

Applicant cannot identify any other arguable basis against patentability in view of the cited art. Consequently, Applicant does not believe a *prima facie* case of obviousness can be made against the new claims herein on the basis of the art of record. However, Applicant requests the Examiner also consider the technological context of the invention as this state of the art helps demonstrate the inventiveness of the instant claims.

The background of the invention describes the technical challenges facing the art prior to the instant invention. Production of SiN films had become an important aspect of semiconductor manufacturing. However the industry faced number of technical problems. Primarily, the issues were one of process speed, thermal budget limitations and down time for maintenance to clean out precipitants. PECVD with, for example TSA and ammonia, had been used in an attempt to speed up film deposition rates. However, the trade off had been lower quality films. LPCVD yielded quality films, but at too slow a deposition rate and using too much heat treatment. Improved reagents for LPCVD to increase deposition rates and reduce the process thermal budget had their own problems of precipitating reaction products and/or undesirable carbon contamination of the SiN films.

An example of prior art attempts to improve LPCVD is U.S. Patent 5932286 (Beinglass). Beinglass independently corroborates the above and the background of the instant application. Abstract; Col. 1, lines 10-20. The solution of Beinglass

was to use elevated pressures in a nonstandard device, i.e. not the standard LPCVD conditions used commercially. Col. 2, lines 15-20; Col. 1, lines 37-57. In addition, Beinglass uses the same dichlorosilane/ammonia chemistry that causes one of the other major technical problem of system clogging by precipitants. Col. 2, line 50-57. Other solutions proposed were even more exotic and remote from pre-existing practices such as use of inductively-coupled plasma high-density plasma and Electron cyclotron resonance (ECR) plasma. "A comparative study on inductively-coupled plasma high-density plasma, plasma-enhanced, and low pressure chemical vapor deposition silicon nitride films," J. Yota, J. Hander, and A. A. Saleh, *J. Vac. Sci. Technol. A* 18, 372 (2000), DOI:10.1116/1.582195; "Silicon nitride deposited by ECR-CVD at room temperature for LOCOS isolation technology," Marcus A. Pereira, Jose A. Diniz, Ioshiaki Doi, Jacobus W. Swart, *Applied Surface Science*, Volumes 212-213, 11th International Conference on Solid Films and Surfaces, 15 May 2003, Pages 388-392, ISSN 0169-4332, DOI: 10.1016/S0169-4332(03)00120-X.

Sato et al (US 2001/0048973) cited by the Examiner is an example of an approach dealing with the precipitant/clogging problem but offers no guidance on the issues of deposition rates or thermal budget limitations.

The art clearly lacked a solution that a) eliminated precipitants, b) reduced thermal budget demands, c) produced commercially viable deposition rates and d) could be directly adapted to the existing LPCVD equipment found in semiconductor fabrication plants. Trisilylamine in combination with hydrazine offered such a solution. Example 1 and Figure 5. Given the foregoing state of affairs and various attempts to solve the set of technical problems facing industry, use of trisilylamine plus hydrazines in LPCVD to make SiN films cannot be viewed as having been an obvious thing to do as of this applications effective date.

CONCLUSION

Accordingly, it is believed that the present application now stands in condition for allowance. Early notice to this effect is earnestly solicited. Should the Examiner believe a telephone call would expedite the prosecution of the application, he is invited to call the undersigned attorney at the number listed below.

Respectfully submitted,

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Date: **January 28, 2011**

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